Conversion to Battery Power

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Converting a track powered locomotive to battery power eliminates all of the electrical continuity problems associated with track power. However, the process of modifying your locomotive and installing electronics can be a bit intimidating. But with a bit of planning and a few tips from those that have gone before you, you will be off to a good start.

Basically, the entire project boils down to knowing what components you will be using, how those components are interconnected, and where they will be installed in the locomotive or train and still be accessible if needed.

Disclaimer: I don't do battery power conversions as a part of my business, G-Scale Graphics. However, I have done many for myself, as well as quite a few for other garden railroaders in the local area. So there are likely many installers out there with more experience than me.

Batteries

Let's start with what can be the largest component, the battery pack. What size do I need? 90% of all the conversions I have done use a 14.8V, 4400mah Lithium-Ion battery pack. Li-Ion batteries provide the most energy in the least amount of space. The 4400 mah is about 2.75"x2.75"x1.5". It will provide around 4-5 hours of run time. Voltage determines max speed of the loco, and mah (milli-amp-hours) determines the run time.

What voltage do I need? Before you tear into your locomotive, run it on track power at the fastest speed you would like to see. Measure the DC track voltage and add 1 or 2 volts. You will need at least that much voltage from your battery pack. More is not necessarily better, because it will just increase the size and cost of your battery pack.

How many mah do I need? Most locomotives with one motor draw less than 1 amp. So a 1000mah battery will run a 1 amp loco for 1 hour or more.

All of my installations charge the battery in place; i.e. charging jack somewhere on the loco, tender, or trail car. So a dead battery means the loco is out of service until recharged. I have several other locos to keep trains running during an open house.

Alternatively, you can install the batteries in a location where you can swap them out to keep the same train running all day. In this case, you can also use smaller battery packs and don't need the charge jack.

Of course you can use an type of rechargeable battery you like; SLA (Sealed Lead Acid), NiCad, NiMh, or even Tool batteries. But they will be heavier and take up more space. The exception is Li-Po, which is small. Li-Po is very similar to Li-Ion, except it doesn't have built-in over charge/over discharge protection like the Li-Ion does, so not recommended.

Battery packs are also available in different shapes, if you have an unusual or tight spot to fit.

Lithium batteries require protection for over charge and over discharge to keep them safe. Without it, they can catch fire. Lithium-Ion batteries have a little circuit board built into the battery pack to provide that

protection. Li-Po's do not. So when a Li-Ion battery is at end of charge, the circuit board just shuts it down; i.e. no voltage output, and your train stops dead in its tracks.

NiCad and NiMh batteries don't need that protection. As they near the end of charge, the voltage will start dropping off and you will see your train start to slow down.

No matter what kind of battery you use, they will need recharging. Just make a habit of putting them on the charger at the end of each run, and you will always be ready to go for the next one.

Space (Where to put it all?)

Now that you've decided on a battery technology and size, you need to figure out where everything goes. The battery is usually the largest component, but you also need space for the radio control receiver (RailBoss4 Basic or Plus), sound board (MyLocoSound or Phoenix), speaker, and any operator controls you may need; power on/off switch, charging jack, programming jack, volume switch.

Ideally, we would like to install everything in the locomotive itself. If you have a diesel, the area under the shell will usually have plenty of room. Steam locos vary. If they have a large tender, that will work. I'm not a fan of installing anything inside of a steam locomotive boiler. Electronics need to be accessible for programming, and trouble shooting. Yes, you may be able to cram some batteries in there, but again, I like accessibility. So if the tender is too small, we need to add a trailing car. Box cars and baggage cars work best. A gondola works with a cover disguised as a load.

So, if we have more than one place to install stuff, how do we split it up? This is determined by the interconnections between cars. Any more than 4 wires between cars is not only unsightly, but may interfere with operation in the turns if too stiff.

Connection to the loco are usually 2 or 4 wires: 2 for the motor, and sometimes another 2 to control the front light, for a total of 4 wires between the tender and the loco. The RailBoss4 and the sound card need to be in the same car, since there are 8 connections between them (motor, battery, and 4 sound triggers). If everything is in the trail car, you only need 2 or 4 wires to the tender(motor, light).

There are lots of scenarios. You may have a track powered steam loco with sound already installed in the tender, but no more room for the rest. Use a trail car, and just send the 2 wire motor power to the tender to run the loco, lights, and factory electronics just as it worked on track power.

Planning at this stage is paramount to success. So think of space, interconnections, and how you want things to operate before you tear into anything. Part of making space may also require the removal of factory electronics; e.g. LGB motor control/sound boards. Or removing standoffs that held the board you removed, along with the 9V battery compartment you no longer need. A lot of this stuff is irreversible, so think twice, cut once.

Your battery and electronics need some additional simple circuitry to operate: A power on/off switch, charging jack, fuse, and a means making multiple power connections to the RailBoss4 and the sound board. Battery Conversion Modules greatly simplify this task by eliminating all of the point to point wiring. Two wires in from the battery, two sets of switched power outputs for the RailBoss4 and sound boards, with a power on/off switch, charging jack, and fuse , all on a small circuit board. The Door Mount version is ideal for trailing cars. Mount it behind the sliding side door for easy access. The Floor Mount version makes the on/off switch accessible from under the tender or somewhere on the side of a diesel shell. We

also have lots of accessories to finish your project: battery connectors for a safe disconnect or swap out of your battery pack, 2 and 4 wire cables for interconnections between cars, reed switches for track activated sounds and station stops, and more.

Mounting the Components

What needs mounting? For the control system: The control board (receiver), battery pack, power on/off switch, charging jack, and fuse. For the sound system: The sound board, speaker, volume switch, programming jack, and reed switches.

If you are installing a sound system, and you don't have a factory installed speaker, installing the speaker should be your first priority. The speaker will have to be mounted in a location where you can create a speaker grill by drilling a large number of holes in the floor within the diameter of the speaker. This will typically be in the center of the car between the trucks. Other components can then be mounted around or on top of the speaker as needed.

The largest components, the control board, sound board, and battery pack, need to be securely mounted, yet accessible and/or removable for servicing. I have several installations where these components are literally just laying in place, unsecured. I get lazy because I often change things out for testing. The down side of this is when you have a wreck, and the car goes upside down, the parts can not only get physically damaged, but upon touching each other, they can short out and damage the electronics.

The battery pack, being the largest and heaviest component we have, needs to be secure. This can be done with Velcro or double sided-foam tape. If you have a choice, place the battery in the center of the car for equal weight distribution. The battery pack should also have a quick disconnect connector on it to allow easy removal or charging without any danger of shorting out the wires. Shorted battery wires will produce in excess of 5 amps, and a very large spark.

Some circuit boards, such as the RailBoss 4 control board, will have mounting holes in the corners. PCB (printed circuit board) standoffs or spacers can be used mount the board just slightly above the floor, using #4 hardware. While this gives a very professional look, it is much easier to just use double-sided foam tape.

Care must be given to mount circuit boards on insulated surfaces. In most cases, that is not a problem with our plastic cars. But you may want to mount your board on top of a metal speaker. The magnet is not a problem for the electronics, other than the metal surface will short out the board. Utilize the mounting holes of the board to mount a sheet of styrene to the bottom of the board. Then use double-sided foam tape to secure the assembly to the speaker magnet. Avoid Velcro for circuit boards, as it is too difficult to remove. The adhesive on the Velcro often gives before the Velcro breaks loose.

Power on/off, fuse, and charging jack can be simplified using a Battery Conversion Module, as we discussed last time. The Door Mount version is supplied with PCB spacers. Use them and #4 hardware for solid attachment to the floor of your box car. It needs to be sturdy in order to operate the on/off switch. The Floor Mount version mounts via the on/off switch hole in the floor.

If you are using discrete components for the power input circuit, you will need to drill the appropriate size holes for each. The best tool for this job is a Step Drill. Drill a 1/8" pilot hole. Then with a piece of masking tape marking the desired depth of "cut" (hole diameter), you can easily expand the hole to the desired dimension. The result will be a perfect hole and normal blood pressure.

That just leaves mounting the reed switches for track magnet activation of sounds and/or automated station stops. These are usually mounted under a truck and require some custom fabrication to precisely place them from the magnets. My defacto standard for triggering placement is Whistle/horn on the right side of the track, and bell/station stop on the left. Please visit this article for more info ... Track Magnets and Reed Switches.

Wiring

Wiring diagrams for all of your components should be available in the instructions or manuals from the manufacturer of your control system and/or sound system. Make sure you understand all of the connections before starting. It may be helpful to make your own drawing of wiring list. Most wiring is just point to point; i.e. from one screw terminal to another. But sometimes multiple connections must be made to the same place, and these are usually noted by a dot on intersecting lines of the drawing to indicate they are connected. No dot, and they are just crossing over each other on the drawing. Multiple connections may require some soldering if you can 't get them all into the screw terminal. Use a low power soldering iron (No solder guns).

The majority of your wiring won't require any significant current capability, so you can use 24 or 22 AWG wire. Always use stranded wire, not solid "hookup" wire. Always tin the end of stranded wire; i.e. give it a coat of solder to stick the strands together. Strip the insulation off the wire a bit further than needed. Tin the wire. There is usually a little round blob of solder on the end. Cut this off for a nice uniform wire ready for insert into a terminal strip. For multiple connections, you can usually only get a maximum of two wires in a terminal strip connection. For more than two, you will have to splice wires together, and just leave a one wire connection to go into the terminal. All wire splices should be covered with heat shrink tubing (best), or electrical tape (if that's all you have).

Larger current carrying wires are required for battery power and motor connections. These should be 22 or 20 AWG wire, again stranded wire.

It isn't necessary to color code all of your wires, but it may be useful to use red and black wires for battery power polarity; red being positive, and black negative.

I like to have a connector on the battery wires, thus allowing for easy and safe disconnection for charging or replacement. Battery wires shorted together will draw an instant 10 amps or more, and make for a good spark! The little red JST connectors are good for this task.

You should also have mating connector pairs on any wiring between cars; tender to loco, tender to trailing car, etc. Two and four wire locking connectors are good for this task. The brightly colored wires can be covered up with black heat shrink tubing. Any more than four wires in one connector with not only be unsightly, but may be stiff enough to interfere with the cars turning.

Needless to say, all wiring should be done with power off. Keep all circuit boards away from any metal objects that could short out traces. You can mount circuit boards on metal objects, such as a speaker magnet, by mounting a styrene sheet on back of the board. Then use double sided tape to mount that on the speaker.

Once you have tested out your wiring, it is nice to clean it up using tie wraps to bundle and route wires.

Document your project as you go! Keep or make copies of the wiring diagrams. Take photos of your installation. Keep a note file explaining why and how you did things. All of this can be scanned into a file on your computer along with links to manufacture's manuals, etc. Documentation makes troubleshooting and repairs much easier, and you can also use it to write an article for your club newsletter or Garden Railways!

Setup

So, does it work? For this discussion, we will assume you have installed a RailBoss 4 Plus, Battery Conversion Module, and a MyLocoSound Steam board.

First, let's charge the battery. We use battery packs and chargers from All-Battery.com. The charger comes with some alligator clips. You will need to cut those off and solder on our Charging Plug with leads. Plug it into the Battery Conversion Module. It doesn't matter if the power on/off switch is on or off. The LED on the charger will be RED during charging and Green when charge is complete.

With your loco on the track, turn on the power and press the "Faster" button on the transmitter. Does the loco start moving? if not, your transmitter probably hasn't been paired with the receiver in your loco. Press the "Learn" button on the receiver. The LED will start flashing. Then press and hold the "Stop" button on your transmitter. Things should work now. Pressing any button should cause the receiver LED to blink off.

Now press "Faster" and get your loco moving. Is it going forward? If not, you need to reverse the wires at the RailBoss 4 terminals M+,M-. The loco should always go forward at power-up.

Assuming you use the default settings on the MyLocoSound steam board, you should get two toots of the whistle when moving off forward. If you got three, you need to reverse the wires on the MyLocoSound terminals M1,M2.

Press the "1" button on the MyLocoSound remote. Does the whistle sound? If not, you need to install two AA batteries in the remote. Also, make sure you are pointing the remote at either the IR receiver on the sound board, or the IR cable.

Next, assuming you are using voltage triggered chuff (not a chuff trigger switch), we need to get the chuffs starting at the same time the wheels start moving. Set the speed to where the loco just starts to move, then press the "Power" button on the MyLocoSound remote. With a little bit of speed, but still slow, we now want to get 4 chuffs per revolution. Use the "Channel Up/Down" buttons until you get the 4 chuffs. Go back and forth between setting starting chuffs, and 4 chuffs, until both are correct.

There are many other parameters you may want to play with on both the RailBoss 4 Plus and the MyLocoSound Steam board, but these will get you started. For the best experience, it is always best to read the manuals. You can find them on our website under Electronics/Manuals & Documents.